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SUBJECT: Study of the Data on the Water Flow of the Helmand River

The Embassy transmits herewith a study of the available data on the water flow of the Helmand River made by Mr. Karl Jetter, Hydrologist of USOM/Iran. Since Mr. Jetter serves under the Geological Survey Division of the United States Department of Interior (U.S.G.S.), he has requested that, according to usual procedures, his report and the four accompanying plates be forwarded to this Division for analysis and review.

This study was undertaken at the request of Ambassador Henderson in an attempt to establish what factual basis there might be in recent available data for the recurrent quarrels between Iran and Afghanistan over the question of the apportionment of the waters of the Helmand River and, primarily, to determine the effects of the operation of the two dams in Afghanistan on the river flow. The data on which this study is based were collected, on the one hand, under the supervision of the U.S.G.S. engineers from six gauging stations in Afghanistan and, on the other, by the Irrigation Department of the Iranian Ministry of Agriculture from two gauging stations on the Sistan River, one of the two distributaries of the Helmand River in Iranian Sistan. The data of the U.S.G.S. were received under cover of USOM A-18 dated April 7, 1954, from USOM/Afghanistan. These data are provisional and preliminary and are subject to review, while the data from the Iranian gauging stations cannot be considered wholly satisfactory. Nevertheless, taken together, these data do offer the possibility of drawing certain broad conclusions:

(1) The two dams in Afghanistan, the Kajakai on the Helmand, and the Arghandab on its tributary, the Arghandab River, in operation since January 1953 and February 1952 respectively, have resulted in a material reduction of the magnitude of the floods and the length of time of flooding in Iranian Sistan and have appreciably increased the low water flows. The more even distribution of the water flow, both from season to season within each year and from year to year, should, under normal irrigation practices, be beneficial to the agriculture of Iranian Sistan.

(2) The total annual quantities of water reaching the Sistan River during the recent period of record have been in excess of those estimated in 1951 by the Helmand River Delta Commission (The "Neutral Commission") as being required by Iranian Sistan. The Commission estimated that Iranian Sistan required an

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annual flow from the Helmand of less than 600,000 acre-feet, whereas the estimated average over the last four years (May 1950 - February 1954) has been 3,000,000 acre-feet and the flow in the driest year was 1,400,000 acre-feet.

(3) In all probability, the extent of the pasture lands in Iranian Sistan will be reduced by the action of the dams, since these pastures are dependent on the flood flows, and the cattle industry in the Sistan Province may thereby suffer.

(4) There is insufficient data to reach an acceptable determination of the quantitative effects of the operations of the Afghanistan dams on the water flow entering Iranian Sistan. The dams have been in operation too short a time, the points of discharge measurement too few, and the records too short to offer valid and accurate long-term comparisons. There are at present not enough gauging stations nor have some of the gauging stations in operation provided satisfactory data.

The Embassy has in preparation a second despatch on the Helmand River that will analyze the recent Iranian note to the Afghan Government on this matter.

For the Charge d'Affairs a.i.

William Koren, Jr.
Counselor of Embassy
For Political Affairs

Enclosures:
1. Interpretation of the Data on the Water Flow of the Helmand River
2. Plate I
3. Plate II
4. Plate III
5. Plate IV

Copies to:
American Embassy, London
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USOM/I

Interpretation of the Data on the Water Flow of the Helmand River

(Report by Karl Jetter, Hydraulic Engineer, U.S. Geological Survey, Technical Advisor USOM/Iran)

1. The two purposes of this review of the Helmand River records are to evaluate (a) the change in river regimen caused by the completion and operation of the two dams in Afghanistan, the Kajakai on the Helmand River and the Arghandab on its Arghandab tributary, and (b) the quantities of water which have flowed into Iranian Sistan during the period of record to determine if Iranian Sistan was receiving its required share of the Helmand River flow as estimated by the Helmand River Delta Commission.

2. The data for this survey were obtained from the following sources:

a) The Geological Survey of the U.S. Department of the Interior (U.S.G.S.), which gives water flow measurements:

Of the Helmand River: above the Kajakai Dam since 1953
below the Kajakai Dam since 1947
at Chahar Burjak (Oct. 1949 to March 1951
Oct. 1953 to date) This gauging station is some 40 miles upstream from the Iranian frontier.

Of the Arghandab River: above the Arghandab Dam since 1952
below the Arghandab Dam since 1948
at Kala Bist, on the Arghandab above its juncture with the Helmand River, since 1950.

It should be pointed out that the data from this source are provisional, but are considered in this report to be good to fair, and reliable during the period of reservoir operation (since January 28, 1953 for the Kajakai dam, and since February 24, 1952 for the Arghandab dam).

b) The Irrigation Bongah of the Iranian Ministry of Agriculture. In 1947 the Bongah established a gauging station about half a kilometer below the Sistan River head, above Band-i-Kohak.* Because of varying backwater from diversion dams downstream, evaluation of the data from this station is very difficult and another station was therefore established in 1950 at a site a short distance below Band-i-Kohak, some 15 kilometers from the Sistan's head. Unless measurements are taken of the water diverted into the irrigation canals between the two stations, the measurements of the total inflow into the Sistan River are not correct. Moreover, the water flow of the Sistan is only a part of the total discharge into Iranian Sistan. The Helmand River divides into two branches after entering Sistan Province, the Sistan and the Parian Rivers. (The latter is also called the Common River and for about ten miles forms the

* Band means dam in Persian

boundary between Iran and Afghanistan. Beyond this the Parian divides into two branches, one of which is the Hirmand River.) No measurements are at present being taken of the water flow into the Parian River system. Therefore, the official Iranian figures of the water flow into Sistan undervalue the amounts of water actually entering the province. However, it is considered that, on the whole, the figures do give an indication of the changes that have occurred in the river regimen as they affect Iranian Sistan due to the operation of the Afghan dams.

3. The effects of the reservoirs on the major source of supply are shown by discharge data furnished by the U.S.G.S measuring inflow and outflow of the reservoirs. The measurements in monthly volumes of water are shown graphically by Plates I and II. The flows at the damsites are subsequently reflected in the flow into Iranian Sistan. Basically, the reservoirs serve to reduce floods by storing surplus waters and to increase low flows by later releasing this surplus.

4. Of the two reservoirs, the Kajakai, with its 1,500,000 acre-feet of storage capacity, controls in large degree the flow from the major contributing Helmand River catchment basin and thus primarily determines the total volume of water as well as modification of floods and low-water flows in Iranian Sistan.

The effect of the Kajakai reservoir on the flow of the Helmand River at the damsite is shown on Plate I. The Kajakai Dam was completed in the latter part of January 1953 and started operation in February, at the beginning of the flood period. The flood period of that year, lasting from the beginning of February through June, provided a total inflow of 3,104,000 acre-feet.* During the period of February through May, when the reservoir was storing, the total flood period inflow was 2,715,000 acre-feet and the total outflow was 1,334,000 acre-feet; the surplus over the outflow, amounting to about 1,381,000 acre-feet (or nearly the reservoir storage capacity), was stored. Hence a little more than half of the flood water was held back from flowing to Iranian Sistan, and the peak flows and duration of flooding were correspondingly reduced. Had this water not been withheld, it would otherwise have contributed to the flood period flows and thereby to the creation of the pasture lands in Iranian Sistan. From June through the following November, 967,000 acre-feet of the stored water were released; after that the inflow again exceeded the outflow and the water was stored. In September, which is the month of the lowest flow, the augmentation of the low period flow by this stored water increased the month's volume from 116,000 acre-feet just below the dam (which would have been the flow without the reservoirs) to 283,000 acre-feet.

During the period from February through November 1953, the reservoir thus withheld a net volume of about 414,000 acre-feet of water, which was not available then for downstream users and was carried over into the next year's operation.

* Figures given are to the nearest thousand.

5. The Arghandab reservoir, with its 395,000 acre-feet of storage, apparently effectively controls the ordinary flows from the small and lower yielding Arghandab River basin. Its reduction of floods must in some measure also be felt in Iranian Sistan. However, because of irrigation requirements in the reaches between the reservoir and Kala Bist, i.e. along the lower Arghandab River, most of the surplus flood waters stored in the Arghandab Reservoir and subsequently released to increase low period flows contribute little to the low period flow reaching Sistan. Since the Arghandab reservoir capacity is insufficient completely to retain the major floods of the River, the contribution of the Arghandab River subsequent to the construction of the reservoir to the volume of water flowing into the Helmand is essentially the quantity during floods which is in excess of the reservoir's capacity.

The effect of the Arghandab reservoir on the flow of the Arghandab River at the damsite is shown on Plate II. The dam was closed February 24, 1952, and started operation at the beginning of the flood period late in February. The subsequent flood period through May, had a total inflow of about 550,000 acre-feet. Of this, about 240,000 acre-feet were released and about 310,000 acre-feet retained in storage (or 57 percent of the flood volume and about 79 per cent of the reservoir's storage capacity). Subsequently, up to the end of the calendar year, there was released from storage a total of about 68,000 acre-feet, contributing only a moderate increase of 2,500 acre-feet to the lowest flow volume in September, increasing the volume from 18,300 acre-feet to 20,800 acre-feet. Hence there were retained in storage by the end of December 1952 about 242,000 acre-feet that otherwise would have flowed towards Sistan.

The small flood of February-April 1953 had a total inflow volume of 311,000 acre-feet, of which 165,000 acre-feet were released and 146,000 acre-feet were stored. The total volume in storage at the end of March 1953 was 365,000 acre-feet, of which 216,000 acre-feet were released during the remainder of the year retaining in storage at the end of December 1953 about 149,000 acre-feet. The release of 34,500 acre-feet in September increased the flow from 7,600 to 42,100 acre-feet during the minimum-flow month.

Except for evaporation losses and the 149,000 acre-feet retained in storage at the end of December 1953, the remaining volume of the total inflow of 1,298,000 acre-feet received by the reservoir from the Arghandab catchment basin during the period February 1952 to December 1953 was gradually released throughout this period. However, it is probable that it did not provide a total volume of water in Sistan equal to what it would have provided had the floods passed uncontrolled, because, as mentioned above, irrigation between the dam and the Helmand River probably absorbs a larger part of the total volume when the flow is regulated. Thus, in two years, a gross total of 455,500 acre-feet of surplus flood flow volume was retained for longer or shorter periods and in some measure must have reduced the total volume which would otherwise have reached Iranian Sistan. An exact determination of the Reservoir's effect will require more complete and up-to-date data from the gauging station at Kala Bist than is at present available to this office.

6. The effects of the Afghan reservoirs on the flow of the Sistan River in Iran are also shown by a study of the daily discharge data obtained below Band-i-Zohak in Iranian Sistan. These data indicate the total Sistan River flow. Since Band-i-Zohak is 15 kilometers below the head of the Sistan distributary (of the Helmand), allowance is presumably made for the diversions in the intervening 15 kilometers. The daily discharge hydrographs are given in Plates III and IV. A comparison of the daily discharge hydrographs for the period prior to operation of the reservoirs with that subsequent to this operation clearly shows the reservoirs' effectiveness in reducing floods and increasing low flows.

During the period of record, 1951 was a year of maximum water supply and 1953 a year of minimum water supply so that direct comparison of the volume of flow would be misleading. Comparison of the two years with respect to the ratio of the volume of water flowing during the flood period to the volume of water during the dry period does, however, illustrate the effects of the reservoirs. In 1951 the waters were not controlled; they were in 1953. In 1951 the total volume of water during the 5 months of largest flow, from February through June, amounted to 3,160,000 acre-feet while the volume of water during the 5 months of lowest flow from August through December, amounted to 326,000 acre-feet -- a ratio 9.8 to 1. The minimum flow was about 550 cubic feet per second. In 1953, the total volume of water from February through June amounted to 890,000 acre-feet and, from August through December to 489,000 acre-feet -- a ratio of 1.82 to 1. The minimum flow was about 1000 cubic feet per second. This makes abundantly clear the fact that the effect of the dams is: (1) to reduce the flood peaks and increase the low water flow, thereby spreading out the water supply throughout the year; and (2) permit a greater consistency of flow from year to year.

The predominant effect of the Kajakai outflow is indicated by comparison of the data from Band-i-Zohak for the calendar year 1951, before either of the reservoirs was in operation, with 1952, when Arghandab alone was in operation. The flood period flows are roughly proportional to the flood volumes at the damsite and show no marked effect attributable to the Arghandab reservoir, and similarly the low period flows. This confirms the relatively minor contributions made by the Arghandab tributary, as deduced in paragraph 5, and, more generally, the conclusions reached in paragraphs 4 and 5 regarding the effect of the dams.

7. The six-year period of concurrent record of the annual inflows from the catchment areas into the reservoirs (Oct. 1947 to September 1953) indicates an average annual volume of about 5,600,000 acre-feet. The minimum volume for this six-year period occurred in 1953, when it amounted to 4,170,000 acre-feet. It was also in the course of this low year that the lowest annual volume of flow, 1,400,000 acre-feet, was recorded for the Sistan River as compared with an estimated annual average of 3,000,000 acre-feet for the four-year period of record. This indicates that, even subsequent to the operation of the dams, Iranian Sistan received in the dry year of record a quantity of water over twice as large as the needs estimated by the Helmand River Delta Commission. The Commission estimated the requirements of the whole of Sistan, to be around 700,000 acre-feet per year, of which about 560,000 acre-feet would be for Iranian Sistan,

and 140,000 acre-feet for Afghan Sistan. Moreover, the figures for the dry year 1953 of 1,400,000 acre-feet and for the average year of 3,000,000 acre-feet, are the volumes of water flowing into the Sistan River only and do not take into account the water flowing into the Parian River.

8. Between the head of the Sistan distributary and Band-i-Kohak five diversion canals were seen, each with inverts considerably above the water surface of the Sistan River; these inverts normally would be high and dry except during periods of floods. The Band-i-Kohak has gates high enough so that when in operation it is believed that flow during low flow periods could be diverted into these higher level canals. Hence, unless the water level is artificially raised by Iranian installations so that water may enter these high level canals, the reduction of the flood peaks now being brought about through storage of flood period flow by the Afghan dams would correspondingly reduce the water available to these canals.

In Summary:

1. The reservoirs have materially reduced the magnitude and length of flooding in Iranian Sistan and appreciably increased the low water period (summer-fall) flows.

2. Because of the reduction in flood flows, the extent of flood pastures or flood flow irrigation will be reduced.

3. It is believed that the data as presented in the daily discharge hydrographs are adequate for comparison of before and after reservoir operation on the regimen of the Sistan River in Iran. During the period of record, these hydrographs indicate that the quantities of water reaching the Sistan River were in excess of those estimated by the Helmand River Delta Commission as being required by Iranian Sistan. They also indicate that the flow is more evenly distributed both throughout the year and from year to year. Such a regulated flow would normally be more beneficial to the irrigation of agricultural lands.